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ABSTRACT

This document consists of energy vocabulary activities, three games, worksheets, laboratory activities/exercises, and an introductory classroom exercise designed to introduce energy concepts to students. Vocabulary activities focus on coal and energy consumption. The three games (with instructions) focus on various aspects of energy and energy consumption/conservation. Content area emphasized, objective(s), materials needed, and instructional strategies and suggested activities are provided for the worksheets and laboratory activities/exercises. Topics of worksheets and laboratory activities/exercises include, among others, paying utility bills; values placed on energy sources; burning properties of different materials; acidity of fly ash; geiger counter experiments; half-life; effects of solar energy on a radiometer; solar collectors; insulators; and water pressure. (JN)

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ACTIVITY SHEETS

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- Coal
-Conservation
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GAMES

-Energy Baseball
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-Save Energy

WORKSHEETS

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-Peak Load Mini-Lesson
-Values

ACTIVITIES and/or LABORATORY EXERCISES

-Best Burns
-Fly Ash Acidity
-Geiger Counter Experiments
-Half-Life
-Insulators
-Radiometer
-Solar (5 investigations)
-Water Pressure

INTRODUCTORY CLASSROOM EXERCISE

-Seek and Find

VOCABULARY ACTIVITY - COAL

Complete the following analogies according to the scheme

black:white::night:_____ (day)

This is read "black is to white as night is to day".

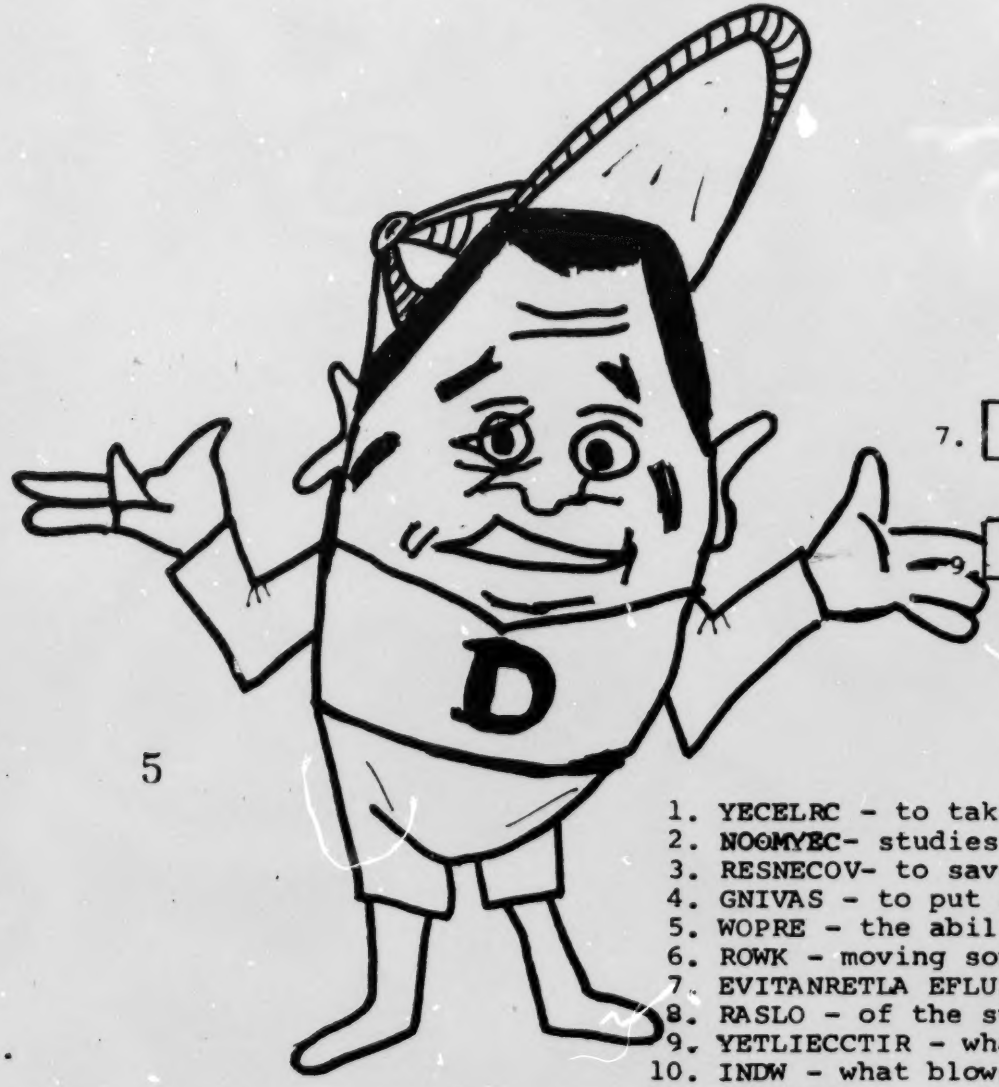
1. Soft:hard::bituminous:_____
2. body:coat::coal:_____
3. planing:drilling::stripmining:_____
4. pearl:necklace::coal car:_____
5. dust:vacuum::fly ash:_____
6. dirt:shower::SO_x:_____
7. fire:ash::scrubber:_____
8. fossils:coal::moss:_____
9. adult:child::coal:_____
10. drilling:shavings::mining:_____
11. carpentry:hammer::stripmining:_____
12. traffic:traffic signal::environment:_____

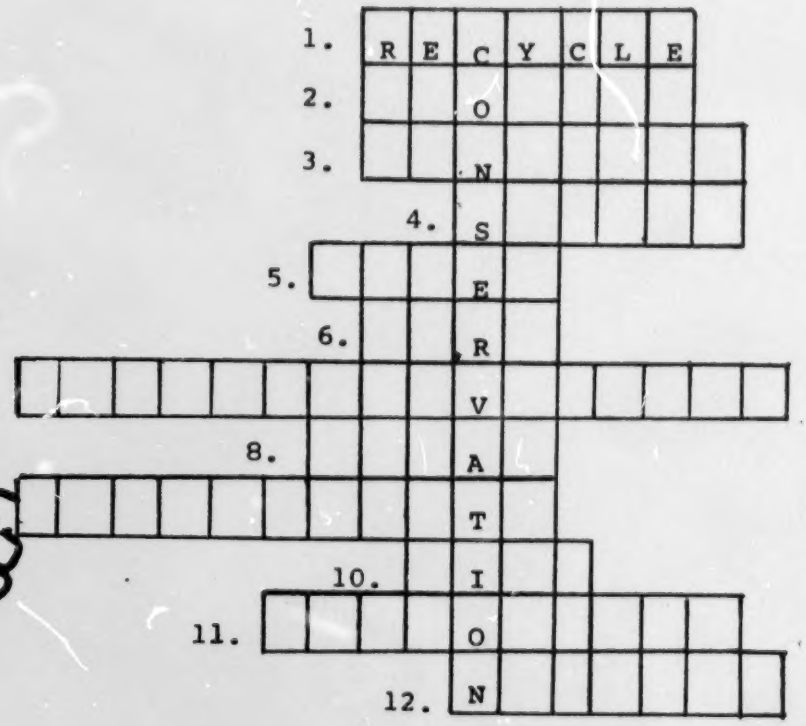
Choose words from the following list to fill in the blanks.

Terms - bituminous
anthracite
lignite
peat
stripmine
overburden
deep mining
draglines
acid drainage
unit trains
EPA
precipitators
scrubbers
fly ash
scrubber sludge

CONSERVATION

SAVING SAM WOULD LIKE FOR YOU TO HELP HIM UNSCRAMBLE THE WORDS SO THAT HE AND YOU PLACE THEM IN THE CORRECT BLANKS. TO HELP YOU SAM HAS ALREADY PUT IN ONE WORD AND AS AN EXTRA HELP HAS PUT ONE LETTER OF EACH OF THE OTHER WORDS. THERE ARE CLUES THAT WILL HELP YOU UNSCRAMBLE THE WORDS.





1. YECELRC - to take something of little use and reuse it.
2. NOOMYEC- studies business
3. RESNECOV- to save
4. GNIVAS - to put away for later
5. WOPRE - the ability to do something
6. ROWK - moving something some distance
7. EVITANRETLA EFLUS - fuels other than fossil
8. RASLO - of the sun
9. YETLIECCTIR - what Duke Power produces
10. INDW - what blows windmills
11. REWDYHROPO - using falling water for energy
12. RNUALEC - energy from the atom

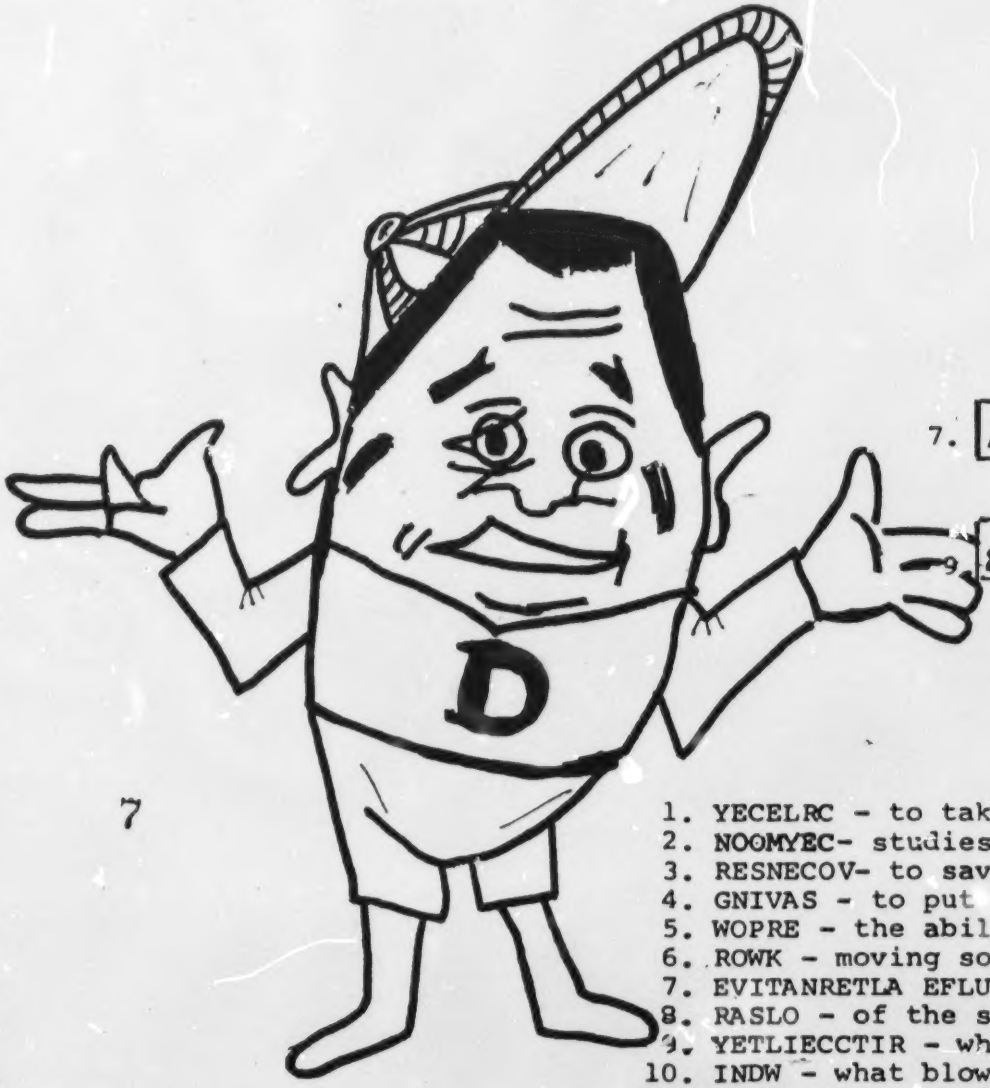
8.1.78

slc

CONSERVATION

KEY

SAVING SAM WOULD LIKE FOR YOU TO HELP HIM UNSCRAMBLE THE WORDS SO THAT HE AND YOU PLACE THEM IN THE CORRECT BLANKS. TO HELP YOU SAM HAS ALREADY PUT IN ONE WORD AND AS AN EXTRA HELP HAS PUT ONE LETTER OF EACH OF THE OTHER WORDS. THERE ARE CLUES THAT WILL HELP YOU UNSCRAMBLE THE WORDS.



1. RECYCLE
2. ECONOMY
3. CONSERVE
4. SAVING
5. POWER
6. WORK
7. AlternativeFuels
8. SOLAR
9. ELECTRICITY
10. WIND
11. HYDROPOWER
12. NUCLEAR

7

1. YECELRC - to take something of little use and reuse it.
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8

1.1.78

slc

BASEBALL

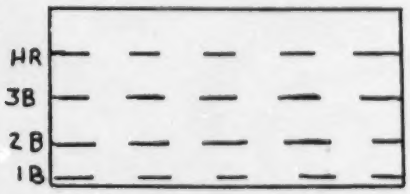
AREA: Social Studies & Science (7-9)

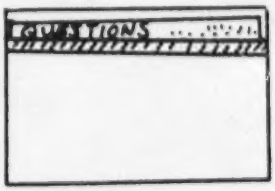
OBJECTIVE: To enhance learning of energy topics through a game.

MATERIALS: Large sheet of tag board or equivalent (18" x 24")
3 x 5 index cards, sissors, tape, felt tip pen.

ACTIVITY: Make four horizontal rows of five pockets per row for questions.

Each row is assigned as single, double, triple, home run.





Divide class into two teams.

An umpire (question reader) is needed.

Have a scorer (use board so all can see the results.)

Set team up in a batting order as in any baseball line-up so no one "hits" out of turn.

Bases can be arranged and players can physically move or this can be done on the board without movement.

The student selects the type of "hit" he/she wishes to try.

If a player misses the answer to the question, that is considered as an out, three (3) outs allowed before the "batting" team changes.

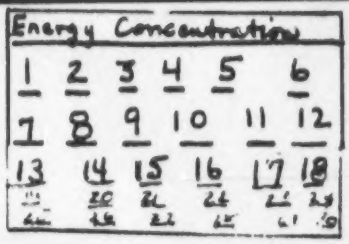
The number of innings can be decided upon prior to beginning the game.

Questions are assigned places on the board according to their difficulty - HRs - hardest and singles easiest.

Unanswered questions are in the row from which they were taken.

Answers are placed on the cards.

CONCENTRATION



AREA: Science (8 - 9)

MATERIAL: Have a board with pockets numbered 1-30 on it. On fifteen cards write questions releated to energy - on separate cards write the answers to the questions -- mix them and number them 1-30. Put them in the corresponding pocket-- on the back of the card in small numbers write the number of the question or answer that goes with that card.

Number of players - 3, 5 or 7. One question and two players or two teams.

OBJECTIVES: Student will be able to answer questions related to energy problems, energy availability and energy alternatives.

ACTIVITY: First player selects two cards. The questioner takes them out, shows them to both teams and reads them aloud.

Questioner must be careful not to show numbers on back of cards.

If the cards go together - give them to the student, if not, return them to the proper pockets.

Player continues to select as long as he makes matches. When he misses, the turn moves on to the other player or team.

Game is finished when all cards are gone from board.

The team or player with the most cards is winner.

CONSUMPTION

AREA: Science (9-12)

OBJECTIVES: 1. Students will find energy consumed by an appliance.
2. Students will find energy involved in heating water.
3. Students will use a conversion for
4. Students will determine efficiency.
5. Students will find cost of operating a small appliance.

MATERIALS: Several coffee makers, water, thermometer, clock, balance.

ACTIVITIES: 1. Heat one kg of water to 80^0-90^oC. Record mass of water, initial temperature, final temperature, and time required to reach the final temperature.
Calculate the energy to raise the temperature of the water.

2. Using the wattage rating on the coffee maker, calculate the energy used.

3. Determine the efficiency of the coffee maker.

4. Calculate the cost of heating the water. (Use the current rate for electricity?

Sample problem (not an actual case!)

Data: Wattage = 1000 W
T_i = 25^oC
T_f = 90^oC
M_{water} = 1 Kg
t = 540 sec.

Calculations: 1) $\Delta H = MC\Delta T$ $\Delta T = 90^o - 25^o = 65^o$
= (1 Kg) (1 Kcal/kg ^oC) (65^oC)
= 65 Kcal

conversion factor: 1 Kcal - 4,184J
$\therefore \Delta H$ = (65 Kcal) ($^{4,184\ J}/_{Kcal}$) = 271,960 J

2) E = Pt
= (1000 watts) (540 sec) = 540,000 J

3) Efficiency = $\frac{\text{energy out}}{\text{energy in}}$ X 100%

= $\frac{271,960}{540,000}$ X 100% = 50.4%

4) cost/kwh = 3.4¢/KWH

E = (1 KW) (540 sec) = (1 KW) ($\frac{540\ sec}{3600\ sec/hr}$)

= .15 KWH

Cost = (.15 KWH) (3.4¢) = .51¢ (just a bit more than half

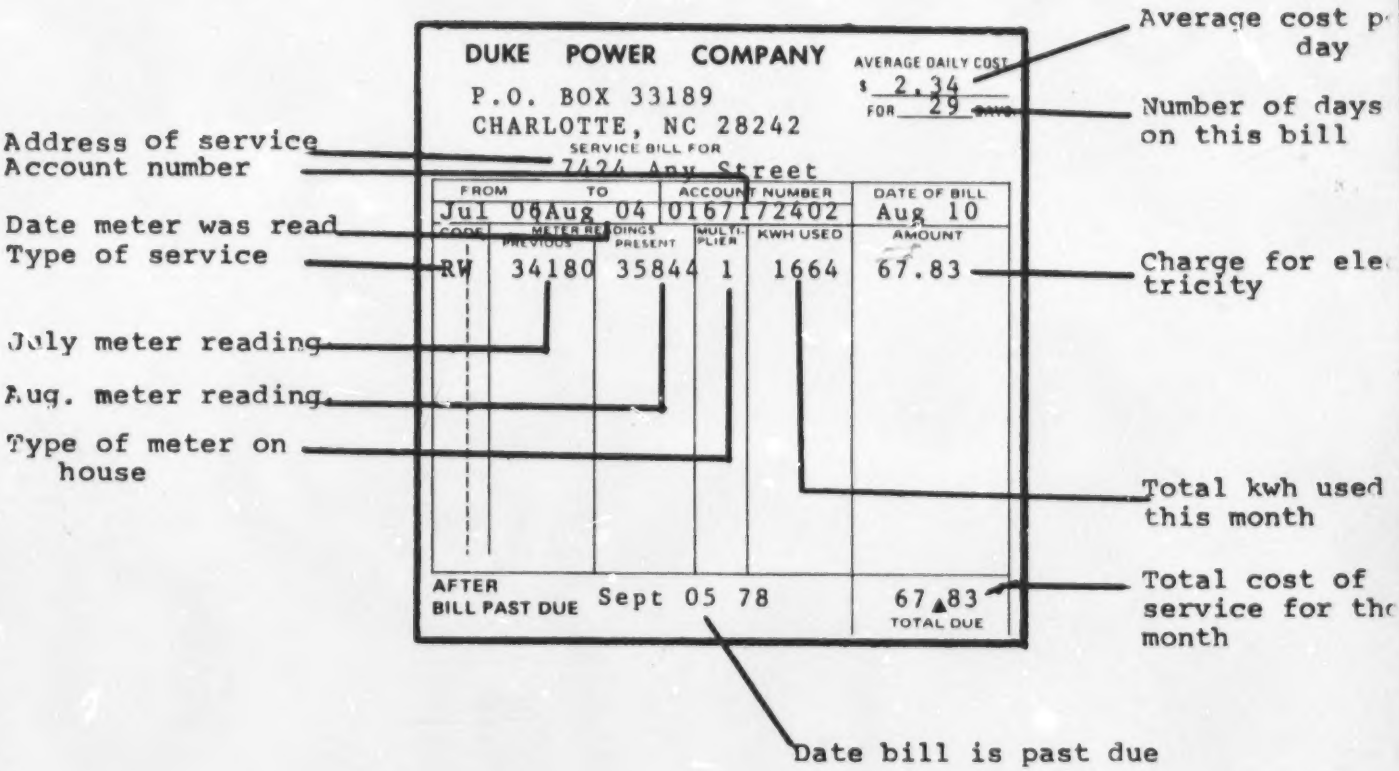
PAYING THE BILL

AREA: Consumer Affairs, Science, Mathematics

OBJECTIVE: To allow students to gain "survival" skills in the area of utility bills.

MATERIALS: copies of the bill below, their own bills (optional), and copy of the worksheet.

ACTIVITY: Using the copy of an electric utility bill found below study the various components listed. Make sure you know what each entry on the bill means.



After you have studied the components of the bill stub above, answer the questions on the following page. The questions are keyed for difficulty level, * literal, ** interpretative, and *** applied. You should answer those indicated by your teacher.

DUKE POWER COMPANY

AVERAGE DAILY COST
$ _____
FOR _____ DAYS

SERVICE BILL FOR

FROM	TO	ACCOUNT NUMBER	DATE OF BILL

CODE	METER READINGS PREVIOUS	METER READINGS PRESENT	MULTIPLIER	KWH USED	AMOUNT
FUEL ADJ COST @			¢	PER KWH	
AFTER BILL PAST DUE					▲ TOTAL DUE

Duke Power

RATE SCHEDULES AVAILABLE UPON REQUEST

PLEASE RETURN THIS PORTION WITH YOUR PAYMENT
A LATE PAYMENT CHARGE OF 1% WILL BE ADDED TO
UTILITY BALANCES 25 DAYS AFTER DATE OF BILL.

DUKE POWER COMPANY

AVERAGE DAILY COST
$ _____
FOR _____ DAYS

SERVICE BILL FOR

FROM	TO	ACCOUNT NUMBER	DATE OF BILL

CODE	METER READINGS PREVIOUS	METER READINGS PRESENT	MULTIPLIER	KWH USED	AMOUNT
FUEL ADJ COST @			¢	PER KWH	
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Duke Power

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DUKE POWER COMPANY

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FUEL ADJ COST @			¢	PER KWH	
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Duke Power

RATE SCHEDULES AVAILABLE UPON REQUEST

PLEASE RETURN THIS PORTION WITH YOUR PAYMENT
A LATE PAYMENT CHARGE OF 1% WILL BE ADDED TO
UTILITY BALANCES 25 DAYS AFTER DATE OF BILL.

WORKSHEET

ANSWER THE FOLLOWING QUESTIONS BASED ON THE COPY OF THE ELECTRIC POWER BILL ON THE REVERSE SIDE.

* 1. WHAT IS THE ADDRESS WHERE SERVICE IS PROVIDED?_____

* 2. WHEN WAS THE METER READ?_____

*** 3. DOES THIS CUSTOMER HAVE ELECTRIC HEAT?_____

* 4. WHEN WILL THE BILL BE PAST DUE?_____ HOW MANY DAYS IS THIS FROM THE BILLING DATE?_____

*** 5. WHAT WOULD THE BILL BE ASSUMING A PROPORTIONAL FUEL CHARGE IF THERE WERE 2 MORE DAYS INCLUDED IN THE BILLING CYCLE?_____

** 6. WHAT COMPANY IS SENDING THIS BILL?_____

** 7. IN THE PREVIOUS MONTH, WHEN WAS THE METER READ?_____

* 8. WHAT IS THE ACCOUNT NUMBER FOR THIS CUSTOMER?_____

*** 9. WHAT IS THE TOTAL NUMBER OF KILOWATT-HOURS USED THIS MONTH?_____ THIS IS EQUIVALENT TO HOW MANY 100 WATT LIGHT BULBS BURNING FOR THE MONTH?_____

DUKE POWER COMPANY AVERAGE DAILY COST $_____ FOR_____DAYS.

Duke Power

SERVICE BILL FOR

FROM	TO	ACCOUNT NUMBER	DATE OF BILL

CODE	METER READINGS PREVIOUS	METER READINGS PRESENT	MULTIPLIER	KWH USED	AMOUNT
FUEL ADJ COST @			¢	PER KWH	
AFTER BILL PAST DUE					▲ TOTAL DUE

RATE SCHEDULES AVAILABLE UPON REQUEST

PLEASE RETURN THIS PORTION WITH YOUR PAYMENT. A LATE PAYMENT CHARGE OF 1% WILL BE ADDED TO UTILITY BALANCES 25 DAYS AFTER DATE OF BILL.

Developed while working with the State Department of Public Instruction in Dec. 1977.

ENERGY MINI-LESSON

DIVISION OF SCIENCE
NORTH CAROLINA DEPARTMENT OF PUBLIC INSTRUCTION

Each issue of The Conserver will include a mini-lesson. The lessons will take an activity-oriented approach to the topic. There will be a short introductory paragraph for tne teacher describing the lesson and a suggested sequence based on field testing.

Peak-load pricing is going to receive testing in N.C. by Duke Power Company. The Utilities Commission is considering similar tests by Virginia Electric Power Company and Carolina Power & Light Company. Since many homes will be affected by this concept, it is desirable that students know what peak-load pricing is.

Based on field testing at Matthews Elementary School, Matthews, NC, the following sequence for teaching is proposed.

Preliminary Activities: 1) Study the basics of graphing. 2) Learn to read the electric meter. (Lesson appears in the SDPI publication, Strategies for Wise Use of Energy.)
Activity: Mini-Lesson
Post Activity: Use follow-up and evaluation materials found in mini-lesson.
Topic: Peak-load Pricing
Grades: 6-10
Objective: Students will prepare a graph showing base, intermediate, and peak loads and use hypothetical figures to determine cost of electricity at various times during the day.
Skills: Graphing, letter writing, hypothesis formation, art.
Materials: Sheet of graph paper, set of 3 different colored pencils, old magazines or catalogs.
Procedure: Label the graph paper with megawatts (MW=1,000,000 watts) on the vertical axis and hours on the horizontal axis. The graphing will be done according to base load, intermediate load, and peak load. (Remember--each load is added for total load.) Use the different colors to represent each load. (Note to teachers: See the completed graph on the back of this sheet.)

Base Load (in MW)		Intermediate Load (MW)	Peak Load (MW)	Total Load
1 a.m.	3,500	1,800	0	5,300
2 a.m.	3,300	1,600	0	4,900
3 a.m.	3,100	1,500	0	4,600
4 a.m.	3,050	1,400	0	4,450
5 a.m.	3,000	1,400	0	4,400
6 a.m.	3,100	1,500	0	4,600
7 a.m.	3,500	1,800	0	5,300
8 a.m.	3,700	2,100	0	5,800
9 a.m.	3,700	2,400	0	6,100
10 a.m.	3,700	2,700	0	6,400
11 a.m.	3,700	2,750	250	6,700
12 noon	3,700	2,750	550	7,000
1 p.m.	3,700	2,750	600	7,050
2 p.m.	3,700	3,100	600	7,400
3 p.m.	3,700	3,200	600	7,500
4 p.m.	3,700	3,200	650	7,550
5 p.m.	3,700	3,200	600	7,500
6 p.m.	3,700	3,200	600	7,500
7 p.m.	3,700	3,100	400	7,200
8 p.m.	3,700	2,750	200	6,650
9 p.m.	3,700	2,750	200	6,650
10 p.m.	3,700	2,750	200	6,650
11 p.m.	3,700	2,750	0	6,450
12 midnight	3,700	2,200	0	5,900

Follow-Up:

1. Write or call your local utility company and ask how they determine the various loads (base, intermediate, peak) and the cost of producing them. (Remember to get all costs in the same unit; for example, $'s per kilowatt hour. [kw---1,000 watts. A kilowatt hour (kwh) is a measure of electric consumption. A 100-watt bulb must burn 10 hours to use 1 kilowatt hour.])
2. Using the graph you have prepared, what do you think causes the load at various times during the day?
3. The graph which you prepared is of a "Typical Summer Day." Would you expect a "Typical Winter Day" graph to be the same? Explain your answer. Check your prediction with the utility company.
4. With the help of your teacher, prepare a picture display of those items in the home, business, or factory which contribute most to the peak load. (Do not cut pictures from school magazines unless your media center has old ones for this purpose.)

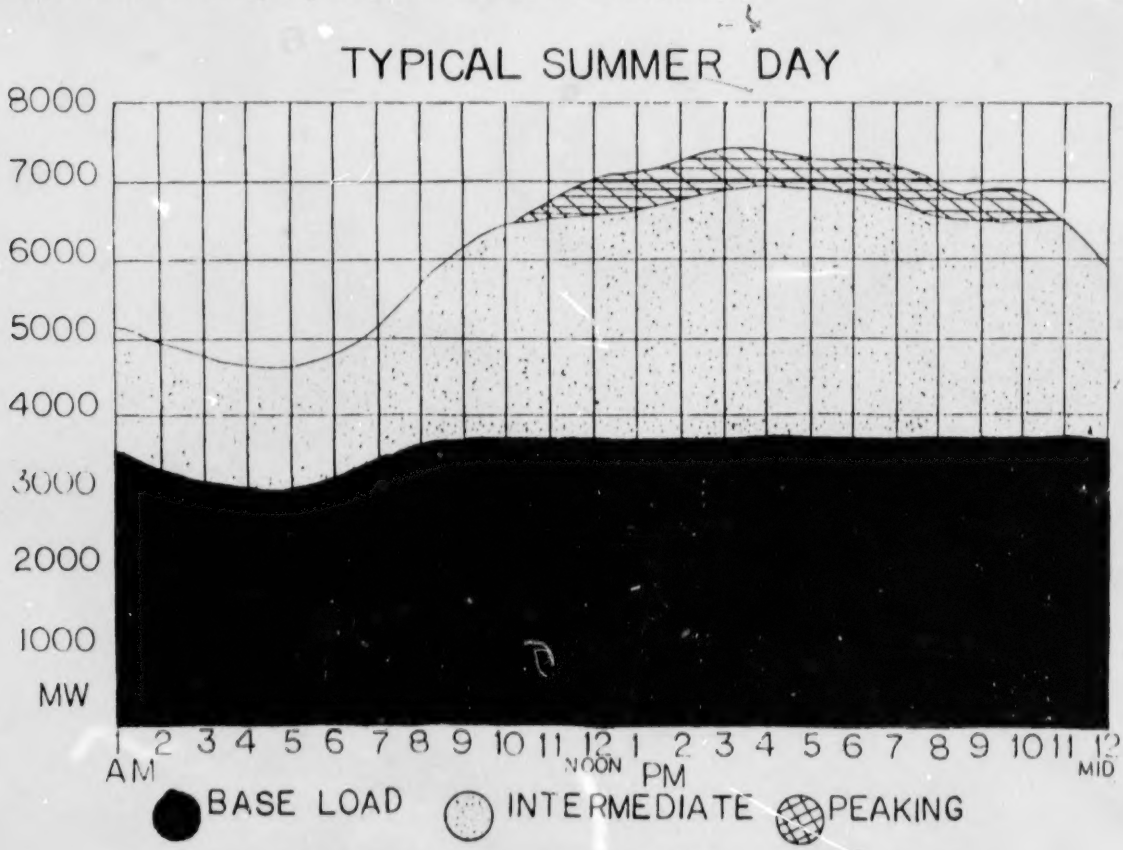
Evaluation:

A. Match the following:

1. load which is most steady	a. peak load
2. load which changes slightly	b. base load
3. load which changes the most	c. intermediate load

B. Short answer:
If it costs $0.07 to provide 1 kwh of electricity at peak-load times and $0.02 to produce 1 kwh at base load times, what will be the difference in a customer's bill if he/she uses 1,000 kwh of electricity at peak prices vs. base load prices?

C. Application: (Using the graph, respond to the following statements with true or false.)
1. Base load changes the least.
2. At times during the 24-hour period, peak load doesn't exist.
3. The smallest load of the day is at noon.
4. The greatest load is at 4:00 p.m.
5. Base load is always greater than intermediate load.



VALUES

AREA: Social Studies and Science (7-12)

OBJECTIVE: To explore intrinsic values placed on various energy sources.

MATERIALS: Charts and word lists.

coal
fossil fuels
hydroelectric
natural gas
nuclear power
oil
solar energy
tidal energy
wind energy

ACTIVITY: Rank the above words 1-9 with one being most favored or "best," 9 being least favored or "worst" - Rank them individually first; then in groups of 4 or 5 - Come up with a group ranking. Have each group report its rankings. Come up with a class ranking - Put the rankings on board and in the chart.

COMPOSITE CHART:

COAL					
FOSSIL FUEL					
HYDROELECTRIC					
NATURAL GAS					
NUCLEAR					
OIL					
SOLAR ENERGY					
TIDAL ENERGY					
WIND ENERGY					
group #	1	2	3	4	5

BEST BURNS

AREA: Science (6-9)

OBJECTIVE: Using different materials the students will observe and record the burning properties of 6 different materials.

MATERIALS: candle, coal, kerosene, alcohol, wooden splint, natural gas (propane may be substituted) matches, fire proof containers, data sheet

ACTIVITY: The student will burn each material called for and observe for the aspects listed on the data sheet. This activity could also be conducted as a demonstration by the teacher with the students observing.

QUESTIONS:

1. why do utilities use a fuel (coal) that is so hard to start and is so smoky?
2. if you had a choice, which of the fuels would you want used in your home? (Consider costs, pollution, availability, heat output-your teacher can help you with these factors.)
3. what do large users of coal have to do to prevent all that smoke from escaping into the air? Is this effective?
4. which of the fuels tested could be used to power automobiles? airplanes? trains?
5. what is responsible for the odors in some of the fuels?

ACIDITY OF FLY ASH

Materials: pHydrion paper
dropper bottle with water
dropper bottle with fly ash/water mixture
paper towel

Activity: Using the pHydrion paper supplied in your kit and the dropper bottle you will conduct the following experiment.

Tear two short strips of pHydrion paper (about 25mm) and place them on the paper towel. Find the dropper bottle labeled WATER (H_2O) and put a drop of water on one of the strips of pHydrion. Observe the color of the wetted strip. Compare this to the color chart supplied with the pHydrion. Place the pH number which corresponds to that color in the space on your data sheet or in your note bock as your teacher prefers.

On the second strip of pHydrion, place a drop from the bottle labeled fly ash/water mixture. Again observe the color and compare with color chart to find the pH of this solution. Record on your data sheet or in your notebook. Your teacher may instruct you to repeat this experiment and average your trials to get a more accurate result.

Questions:

1) Keeping in mind that a pH of 7.0 is neutral; 1.0 is very acid; and 14.0 is very basic - how does the fly ash/water mixture rate?

2) If most plants need a pH of 7-9 to grow best, what could be said about plants growing where fly ash is to be stored?

Data:

Water (H_2O)	Fly ash/water combination
pH=_____(1st trial)	pH=_____(1st trial)
pH=_____(2nd trial)	pH=_____(2nd trial)
Average pH=_____	average pH=_____

GEIGER COUNTER EXPERIMENTS

AREA: Science (6-12)

OBJECTIVE: Students will learn about radiation and the operation of a Geiger counter.

MATERIALS: Geiger counter*, radiation sources (alpha, beta, gamma) metric ruler, data sheets, shielding materials

ACTIVITY: Follow the instructions carefully and your reward will be a satisfactory experience.

1. Turn on the Geiger counter and set the counter for the lowest multiplication factor. (usually x0.1). This means the count as registered on the dial is multiplied x0.1.

2. Record the number on the dial every 30 seconds for 3 minutes. Take the average of these 7 numbers. This is the average background radiation. Remember your multiplication factor.

3. Take the alpha source and place it in contact with the front of the tube. Follow the same procedure as you did with the background radiation.

4. Do the same with the beta and gamma sources. NOTE: If there is so much radioactive decay that the counter goes all the way over it may be necessary to turn counter to (X1) or (X10). If this is necessary, remember to multiply your reading accordingly.

5. Using your information from #2, #3, and #4, draw a bar graph showing radiation levels.

6. Try various shielding materials for their effectiveness on the various radiation sources. (paper, aluminum foil, books, glass, etc.) Record what you used and their effectiveness. You must use the same procedure for recording radiation as before.

7. Next try distance (use only the gamma source) as a radiation shield. Try the following distances 10mm, 100mm. 1000mm. Record your dates and plot a graph of the radiation.

*Instructions for constructing a Geiger counter are found in NUCLEAR EXPERIMENTS UOU CAN DO, Thomas Edison Foundation, Southfield, Michigan

Name_____

Period_____

Date_____

DATA SHEET

This sheet is provided for you to keep track of your data. The numbers refer to the instructions.

2. Background radiation

Initial reading_____mr/hr
+30 sec_____mr/hr
+60 sec_____mr/hr
+90 sec_____mr/hr
+120 sec_____mr/hr
+150 sec_____mr/hr
+180 sec_____mr/hr

$\frac{\text{Total}}{7}$ = avg. background

3. Alpha radiation

Initial reading_____mr/hr
+30 sec_____mr/hr
+60 sec_____mr/hr
+90 sec_____mr/hr
+120 sec_____mr/hr
+150 sec_____mr/hr
+180 sec_____mr/hr

$\frac{\text{Total}}{7}$ - background = alpha radiation

4. Beta radiation

$\frac{\text{Total}}{7}$ - background = beta radiation

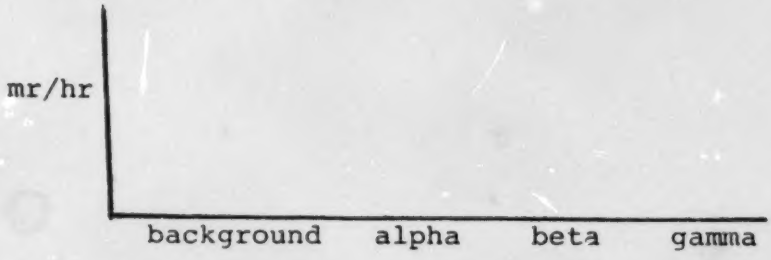
Initial reading_____mr/hr
+30 sec_____mr/hr
+60 sec_____mr/hr
+90 sec_____mr/hr
+120 sec_____mr/hr
+150 sec_____mr/hr
+180 sec_____mr/hr

Gamma radiation

Initial reading_____mr/hr
+30 sec_____mr/hr
+60 sec_____mr/hr
+90 sec_____mr/hr
+120 sec_____mr/hr
+150 sec_____mr/hr
+180 sec_____mr/hr

$\frac{\text{Total}}{7}$ - background = gamma radiation

5. Graph of sources



6. Shielding effectiveness

	alpha shielding	beta shielding	gamma shielding
#1 _____	_____ mr/hr	_____ mr/hr	_____ mr/h
#2 _____	_____ mr/hr	_____ mr/hr	_____ mr/h
#3 _____	_____ mr/hr	_____ mr/hr	_____ mr/h
#4 _____	_____ mr/hr	_____ mr/hr	_____ mr/h

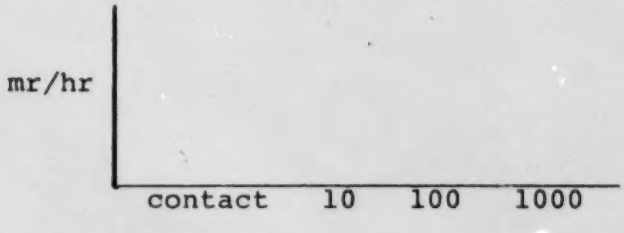
7. Distance as shielding (using gamma)

Contact reading _____ mr/hr
(from #4)

10mm _____ mr/hr - background = _____

100mm _____ mr/hr - background = _____

1000mm _____ mr/hr - background = _____



QUESTIONS:

1. Which source of radiation is most penetrating?
2. What makes up background radiation?
3. Which shielding material(s) stop(s) alpha? beta? gamma?
4. Why is distance effective in shielding one from radiation?

HALF / LIFE

AREA: Science (8-9)

OBJECTIVE: Using a model student plot a graph illustrating the half-life of a radioactive element (pennies).

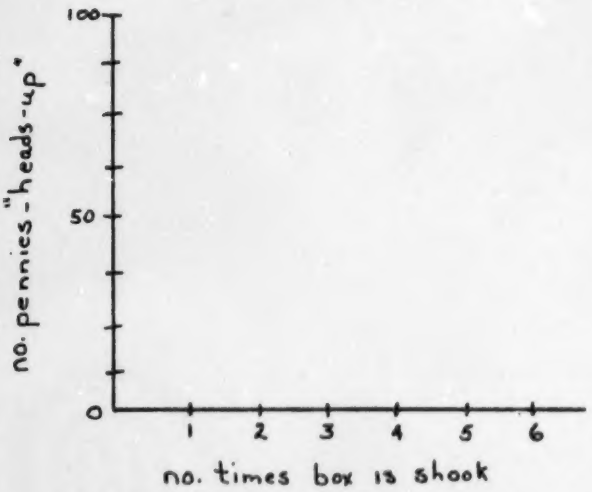
MATERIALS: box, 100 pennies.

ACTIVITY: Place 100 pennies "heads-up" in a box. Close the box, and shake it in all directions for several seconds. Now open the box and look at the pennies. The pennies that are lying "heads-up" are radioactive atoms and those "tails-up" are decomposed.

Count the "decomposed" pennies and record the number. Remove these from the box.

Repeat this several times and record the "decomposed" pennies each time.

Plot the results on a graph.



The amount of time it takes to shake the box and have one-half of the pennies to "decay" is the half-life.

RADIOMETER

AREA: Science

OBJECTIVE: To learn more about solar energy as seen through effects on a radiometer.

MATERIALS: radiometer; light source, various light shields, stop watch or watch with second hand, data tables

ACTIVITY: Place the radiometer on a stationery surface. Turn on your light source. After about 1 minute count the number of revolutions. Using the materials provided for light shields - shield the radiometer and again check for number of revolutions (allow a minute for stabilizing after each new source is used. Record your data in the tabl provided.

NOTE: If your light source causes the radiometer to spin faster than you can count, then move the source further away.

DATA TABLE

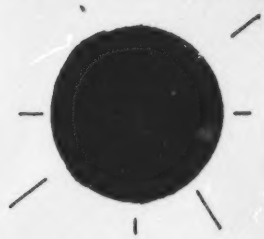
Light source:_____ approximate distance_____

# of revolutions	shielding material
_____	none
_____	_____
_____	_____
_____	_____
_____	_____

QUESTIONS:

1. what causes the radiometer to turn?
2. why do the different shielding materials cause different behavior in the radiometer?
3. Could this principle be adapted to power generation? Why or why not?
4. what is necessary to produce a working radiometer?

SOLAR



COLLECTORS:

Materials: knife, aluminum foil, black paper/cloth/or paints, transparent tape, ^{o}C & ^{o}F thermometers, clock, 2 boxes

Construction: Procure two identical cardboard boxes about 12-16 inches square. Cut a slit in each and cover with clear plastic. Temperature readings will be taken by looking through this window. Cover remainder of boxes completely -- one box with aluminum foil and the other with black paper, cloth, or paint. Make a hole in the middle of one side and insert thermometer so that bulb is in center of box. Position thermometer for clear visibility through the window.

Note: Before continuing to the actual investigations, teacher should see that each team clearly understands the procedure and is using same time intervals.

INVESTIGATION I

A. Place both boxes flat on similar surface. Take initial reading and record. Immediately continue to take readings at specific time intervals (pre-determined) for total time. Record all readings.

B. Immediately after last reading move the collectors to the shade and continue readings at same time intervals until temperature returns to the initial reading. Record data.

C. Interpretation of data: (from both boxes)

1. Is there a relationship of colr to amount of energy collected. Explain.
2. How hot does air become in each box? Explain and graph.
3. How long does air retain this gained heat energy? Explain and graph.

D. Conclusion: Write a concise statement based upon your data.

INVESTIGATION II

Additional materials: ruler & protractor.
Repeat Investigation I, A and B, after each team positions the collector so that the top (window face) is in direct line with the sun's rays. Students must (1) devise way to keep the collector properly oriented (2) decide whether to modify original data table or construct another (3) decide whether to plot this data on Graph I or construct a new graph.

Compare data from Investigations I and II.
Interpret.
Draw and write concise conclusion to entire activity.

INVESTIGATION III (optional)

Each team repeats Investigations I and II, using ^{o}F thermometer
Each team devises way to compare ^{o}C and ^{o}F readings
Optional: Teacher introduces temperature conversion equations OR assigns student research on this topic.

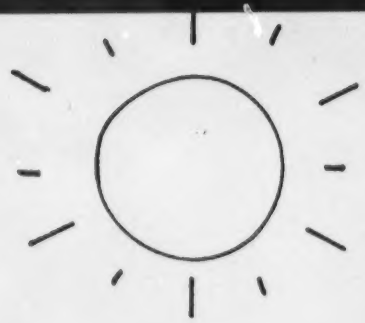
INVESTIGATION IV (optional)

A. Repeat I on cloudy day. Compare
B. Devise way to put container of water and container of crushed rocks in box and measure heat absorption. Compare data.

FOLLOW UP: What is the potential use of passive solar collectors (a) on a DIY basis? (b) on a commercial basis? (c) does geographical location affect feasibility of passive solar energy? (d) if this is a year's course, relate to seasons (solstices)

DO INVESTIGATION in June/Dec. Compare/Explain.

SOLAR



AREA: Earth Science - (8)

OBJECTIVE: One alternative solution to the "energy crisis" involves using passive solar collectors for heating both buildings and water. This is a "do it yourself" team activity involving periodic decision making, that will permit students to:

construct simply apparatus
plan strategy for collecting data
graph and interpret data
draw and write concise conclusions
compare ^{o}C and ^{o}F readings (math conversions optional)
plan further infestigations

This INVESTIGATION is divided into four parts each logically following the preceding part, but the INVESTIGATION can stop at any of the four parts. Perhaps a teacher will wish to use Parts I & II activities for more advanced students.

ACTIVITY: Role of teacher: after introducing background material, teacher should make decision on team arrangement and, in planning stages, see that all teams use same time intervals. Other decisions should be left up to the team members...much learning will take place during these planning sessions. Teacher should either collect minimal props or assign this to teams. Teacher should act as an "activator," moving from group to group, asking provocative questions when direction is needed. Concept of control/variable may be introduced, reviewed, or ignored.

Individual and Team objectives/skills:

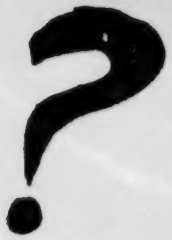
1. Determine realistic time intervals for readings
2. Construct data table(s)
3. Construct graph(s)
4. Construct collectors according to directions given
5. Interpret data by answering questions
6. Draw and write concise conclusions based upon data
7. Determine way to measure angle and stabilize collector at proper orientation to sun

(optional) 8. Plan further investigations

9. Take accurate readings from thermometers & develop understanding of Centigrade/Fahrenheit comparisons

(optional)10. Develop understanding of mathematical conversion C/F temperatures.

SEEK & FIND



AREA: Social Studies, Science, English, Math

OBJECTIVE: To introduce students to each other while also introducing them to energy concepts.

MATERIALS: Scavenger hunt sheets, pencil or pen

ACTIVITY: Students mingle and get signatures of other students/ teacher who possess the named appliance or who do the named chore. Each student must say his/her name prior to getting a signature. A student may not sign more than one line nor his/her own sheet. Set a time limit; the person with the most signatures wins!

_____ Car pools to school (usually)
_____ Rides a bus to school
_____ Walks to school
_____ Color TV
_____ Black and white TV
_____ 4 cylinder car
_____ 6 cylinder car
_____ fireplace
_____ storm windows
_____ compost area
_____ thermal underwear
_____ knee socks
_____ take a shower
_____ take a tub bath
_____ storm doors & windows
_____ gas heat
_____ electric heat pump
_____ unairconditioned car
_____ window air conditioner
_____ self cleaning oven
_____ defrosts refrigerator/freezor
_____ stereo
_____ electric blanket
_____ floor insulation